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29 December 1964

MEMORANDUM FOR THE RECORD

Subject: Spatial Filtering Viewer, Itek Corporation,  
Contract No. BB-425, T.O. 4

*Proj. File  
# 4016*

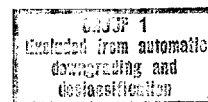
- References: (a) Itek Corporation, Final Report, Itek Project No. 9043, 23 October 1964, "A Study of Spatial Filtering Using the Image Enhancement Viewer.
- (b) Itek Report "Band Pass Filtering of an Aerial Negative Using the Image Enhancement Viewer," 4 November 1964.
- (c) Memorandum for the Record dated 30 September 1964 (from [REDACTED], Subject: Determination of a Transfer Function for the Coherent Light Enlarger.

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1. On 16 December I visited the Itek Corporation to discuss the results of the subject contract. Prior to this visit the reports of references (a) and (b) were received and evaluated. Reference (a) reports the results of theoretical and experimental investigations to determine the usefulness of the Spatial Filtering Viewer using occluding filters. Reference (b) contains a series of transparencies which have been filtered with sharp cutoff, occluding spatial filters. These must be viewed at low magnification to observe the details. The photographic transparencies of reference (b) clearly show what occluding filters do and cannot do to a photographic image.

2. The report of reference (a) outlines the steps taken to test theory against experiment. It is my opinion that the investigations were well conceived and carried out successfully; i.e., within the limits of experimental error, theory and practice correlate well. The conclusions follow logically, although most are negative. In general, the so-called Image Enhancement Viewer enhances little, if anything. Indeed, the image is generally degraded and the contrast about sharp edges is visibly altered. While those edges appear to stand out, the image quality over the field has obviously dropped. In fact, sharp edges need no such effects to better their visibility. Under carefully controlled experimental scrutiny, this new presentation of the old edge does not materially aid or improve mensuration or interpretation. This is one of the questions that the investigation was to settle, and it has -- there is no practical enhancement or really useful filtering with sharp cutoff, occluding filters. However, this is not a severely critical statement inasmuch as enhancement in the present optical context remains singularly undefined.

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3. Part 5 of reference (a) deals with real aerial transparencies. The results were negative, and coherent spatial filtering under all circumstances provided no more information than that ordinarily obtainable under incoherent illumination. In view of the recent problem of evaluating the Perkin-Elmer Coherent Light Enlarger, outlined in reference (c), such negative results can be expected. It is unfortunate that much of the information about the problem of coherent-versus-incoherent resolution limit was not known to us earlier. The major consideration here is that in a coherent system the transfer function is related to the object, and this means that each useful spatial filter, necessarily related to the object, is essentially unique. This further implies the unrealizability of a general, optimum filter -- a basic factor seriously limiting the usefulness of the viewing device.

4. We are currently considering the evaluation of the Perkin-Elmer coherent light enlarger. This involves a great deal more than physical assessment of image quality and will be deeply concerned with the fundamental meaning and utility of the coherent transfer function. Until this problem is solved, therefore, it will be impossible to provide adequate technical guidance for continued development involving coherent spatial filtering. There is another, more practical factor which further hampers such endeavors. The photographs in which image structure may be most easily changed through filtering are those of the highest quality: i.e., photographs possessing significant information densities in the high spatial frequencies. These, of course, need little or no filtering at all. On the other hand, for low quality photographs (which are those most desirable to improve) suitable spatial filters are incredibly difficult to produce. This stems from the fact that a poor photograph has a reduced high spatial frequency content, with a resultant compacting of information in the Fraunhofer pattern. In order to effect a significant change, the spatial filter (be it continuous-tone or occluding) must be dimensionally smaller than the total energy spread in that pattern. Previous work on continuous-tone filters indicated that the limits of the state of technology were quickly reached for photographs requiring very little improvement. Smaller filters required a breakthrough in technique and materials. Thus, there is a need for an improved method for making the exceedingly small filters which are required. The problem of optimum filtering remains to be investigated, in order to ascertain filter attenuation cross-sections. In short, the practical difficulties are in step with the conceptual uncertainties. It is for these two reasons that I recommend we hold spatial filtering investigations in abeyance. Perhaps the results of our current evaluation of coherent system properties may provide a way out of this theoretical/practical dilemma.

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